Bedrock

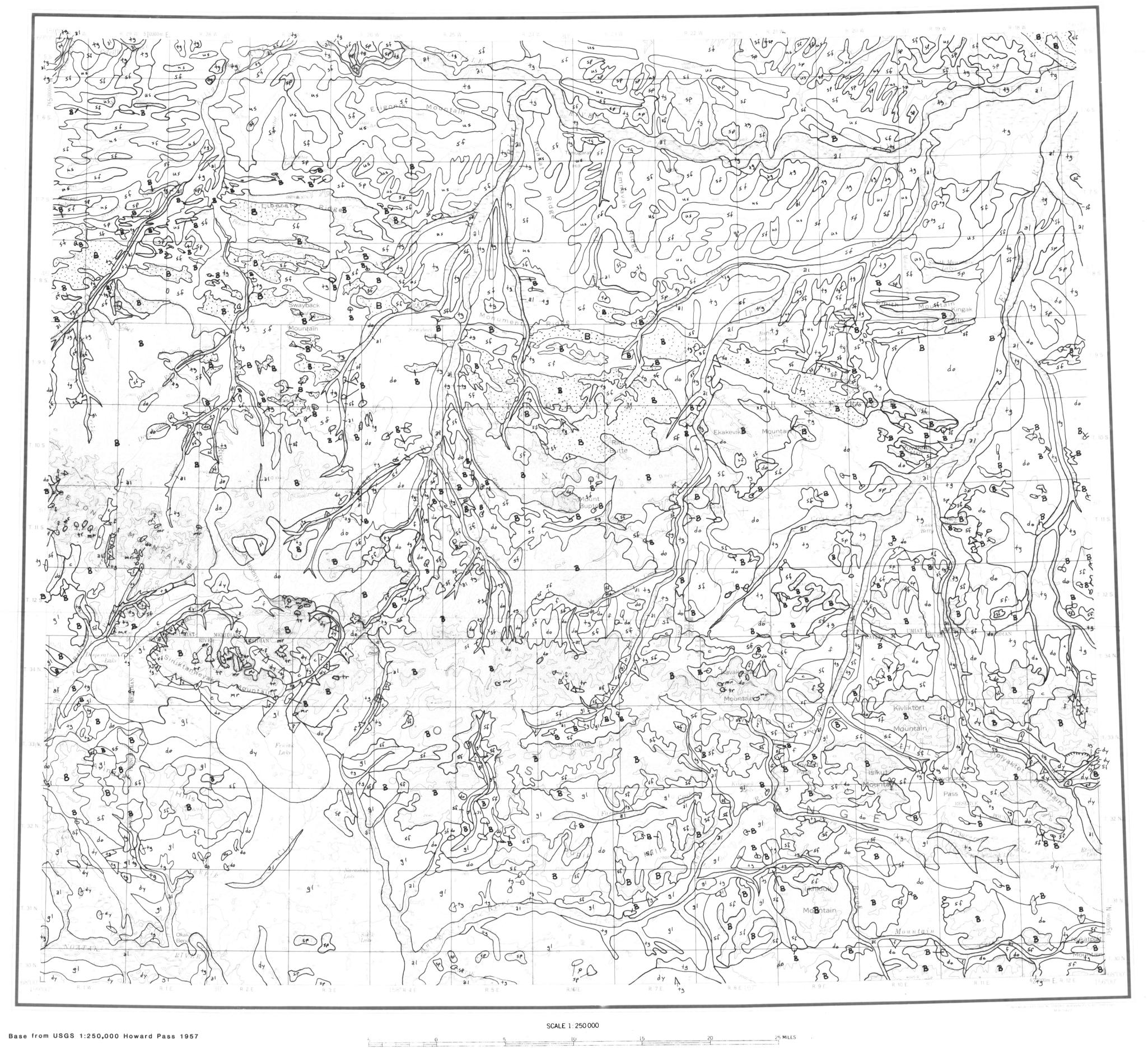
exposures.)

Mountains. (Stippled pattern designates discontinuous bedrock exposures separated by

sheets of silt and colluvium; patternless areas are generally continuous bedrock

in the mountains and 400 m in the foothills

HOWARD PASS



CONTOUR INTERVAL 200 FEET

INTRODUCTION

The Howard Pass quadrangle covers a physiographically diverse area of about 14,000 km² in northern Alaska. To the south, the map area extends into the central Brooks Range and the De Long Mountains, and also includes part of the Noatak Lowlands (Wahrhaftig, 1965). To the north, it extends across the southern Arctic Foothills to the broad valley of the Colville River. Relief generally is low (150 to 200 m) in the Colville and Noatak Valleys, somewhat higher (200 to 400 m) in the Arctic Foothills, and highest (500 to 1,000 m) within the mountains.

The Brooks Range consists of sparsely vegetated mountain masses that are separated from each other by deep valleys with low divides that were carved by glaciers that originated south of the map area. Lithologies are dominantly limestone, quartzite, sandstone, shale, and siltstone of Devonian through Permian age. The De Long Mountains are more varied in lithology, including volcanic and ultramafic rocks of Jurassic through Permian age in addition to the rock types that dominate farther east. Valley heads are deeply indented by cirques, and the De Long Mountains were a source for glaciers that flowed north and south into the adjacent foothills and lowlands. The Arctic Foothills, an east-west-trending fold belt, consist of generally unglaciated ridges whose relief, shape, and surficial cover are controlled by rock resistance. Sandstones and conglomerates underlie the steepest and highest ridges, which commonly bear only a thin mantle of talus. Shales and siltstones underlie more subdued ridges, which commonly are covered by thick deposits of ice-rich silty loess and colluvium. The Noatak Lowlands, which form a broad intermontane trough, were dammed by glacier ice during several episodes of late and middle(?) Pleistocene glaciation (Hamilton and Ashley, 1983). This depression is filled with a complex of glacial, glaciolacustrine, glaciofluvial, and fluvial sediments with a probable maximum thickness of several hundred meters.

Permafrost is continuous throughout the map area. Depth of the active layer ranges from 20 to 40 cm in poorly drained deposits beneath thick sod and peat to half a meter or more in permeable coarse-grained sediments. Unfrozen zones several tens of meters thick may exist beneath the larger lakes and rivers. Although total thicknesses are unknown, records elsewhere in northern Alaska (e.g. Ferrians, 1965; Williams, 1970) suggest that the base of permafrost may lie at depths of 150 to 250 m in much of the map area.

This map has been prepared with partial support of the Bureau of Land

Management, Department of the Interior. It is a generalized version of U.S. Geological Survey Miscellaneous Field Studies Map MF-1677, Surficial geologic map of the Howard Pass quadrangle, Alaska (Hamilton, in press), which was based on helicopter-supported field mapping during 1977, 1979, and 1982. Seventy-one surficial geologic map units were defined in MF-1677, and these have been generalized into 12 units on this map to facilitate presentation of engineering properties in the form of a tabular text. The complex bedrock geology of the Howard Pass quadrangle has been mapped locally (Chapman and others, 19764; Tailleur, Kent, and Reiser, 1966; Mayfield, Tailleur, and Sable, 1978; Nelson and Nelson, 1982), but is imperfectly known elsewhere in the map area. For this reason we have shown bedrock as a single undifferentiated unit on our

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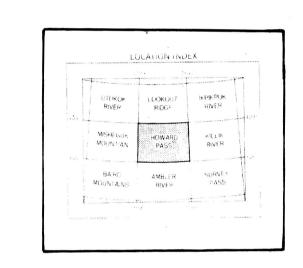
Professional Paper 482, 52 p.

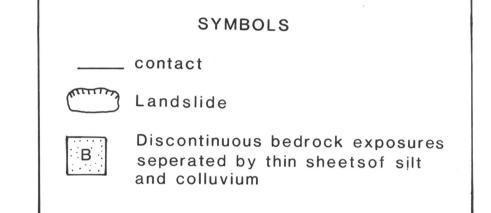
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Equivalence of engineering-soils units used in this map to surficial geologic units shown on U.S. Geological Survey Map MF-1677.

| This Map | MF-1677 |
|---|--|
| Alluvium (al) | al, al ₁ , al ₂ , al-sa, als, sa |
| Terrace gravels (tg) | $\begin{array}{l} \text{tg, tg}_1, \text{ tg}_2, \text{ Ttg, wo, wo}_1 \text{ wo}_2, \text{ wi, io, io}_A, \\ \text{io}_A, \text{io}_B, \text{ii, so, so}_1, \text{so}_2, \text{sk, ao, Tgmo, gr} \end{array}$ |
| Younger glacial drift (dy) | wd, wd $_1$, wd $_2$, wk, id, id $_A$, id $_B$, ik, b |
| Older Glacial drift (do) | sd, sd ₁ , sd ₂ , ad, ad-E, ak, Tgmd, Tgmd-E, d |
| Glacial lake deposits (gl) | $\label{eq:wgl} \begin{array}{l} \text{wgl, igl}_A, \ \text{igl}_B, \ \text{igl/sd, igl/so, igl/sdt, sgl}, \\ \text{sgl}_1, \ \text{sgl}_2, \ 1, \ \text{dt} \end{array}$ |
| Fan deposits (f) | af, af _i , f, f _i , fd |
| Solifluction deposits (sf) | sf |
| Upland silt deposits (us) | us |
| Talus deposits (tr) | tr _i , tr _a |
| Holocene glacier and rock glacier deposits (mr) | nd, rgi, rga |
| Silty and peaty depression fillings (sp) | sp, tl |
| Colluvium (c) | c, pes |
| Bedrock (B) | None |





Description of Map Units Description of Materials Distribution of and Thickness Topography and Drainage Permafrost Susceptibility to Frost Action Suitability for Construction Special Problems Range from poorly sorted, moderately well stratified, subangular coarse gravel near Include fan, flood-plain, and low terrace deposits that are less than 3-5 m above river Forms strips of low relief along valley centers. Active stream channels and bars are Perennially frozen except perhaps for thaw bulbs beneath deep pools of larger rivers. Granular alluvium having silt content below 6 percent is generally not frost susceptible. Gravel and sand provide good foundations, except where thin and underlain by clay or Subject to bank erosion, channel scour, and seasonal flooding, except on the highest heads of mountain valleys to moderately well sorted, gravelly sand and sandy fine gravel level. Thickness ranges from less than 1 meter where streams cut bedrock to several bordered by vegetated flood plains and terraces. Crescentic lakes (meander scrools) on Active layer 0.3 m thick beneath older vegetated surfaces; increasing in thickness to 2 m Fine-grained, organic-rich overbank deposits and channel fillings are highly frost ice-rich silt. Granular borrow material limited, except for the largest streams. Organicterraces. Aufeis forms along some channel segments during winter months. Access may along slow-flowing stretches of major streams. May contain local beds and lenses of sand meters along smaller streams and 10 meters or more along major river valleys. younger surfaces are modified by thaw-lake processes into more equidimensional lakes on or more beneath active channels and bars. Ice wedges are present in many of the older rich silt of thaw lakes and channel fillings is not suitable for foundations. be difficult owing to breakup and freeze-up processes and to winter ice cover. Alluvium and sandy silt. Boulders commonly are present as lag concentrations where streams cut older surfaces. Younger surfaces generally well drained; older surfaces become floodplains and low terraces. Silty channel fillings commonly contain abundant ice lenses glacial deposits. Older vegetated deposits contain overbank silt, organic silt, and fine progressively more marshy with increasing age. and disseminated ice. sand above sand and gravel. Extend along river valleys as paired strips that border modern and recent alluvium. Forms gently sloping, benchlike terraces that border modern streams and their Organic-rich silty loess and solifluction deposits that cap the gravels are highly frost Entirely underlain by near-surface permafrost, with active layer generally 0.3 to 0.5 m Overlying deposits of ice-rich silt require special techniques such as insulated pads or Drainage generally is poor because of frozen state and overlying fine-grained deposits. Gravel or sandy gravel, subrounded to well rounded, of variable composition. Bears Sediments generally range in thickness from 5 to 20 m, and occur in terraces that stand floodplains. Drainage poor to very poor, with marshes and thaw lakes common. susceptible. Underlying gravels are not frost susceptible except where silt has infiltrated thick. Ice content moderate to high; ice wedges commonly present. thermopiles for foundations. Overlying deposits are subject to thermal erosion where insulating vegetation is mantle 0.3 to 10 m thick of ice-rich silt, organic silt, sand, or peat (loess or solifluction up to 60 m above modern river levels. Bedrock commonly is exposed beneath gravel in from above and filled intergranular voids. damaged. Subject to gullying along terrace edges. deposits). Older terraces generally have greater silt content and thicker loess and Terrace gravels the highest terraces. solifluction cover than younger terraces. Unsorted to poorly sorted, generally nonstratified, compact till ranging in composition Restricted to mountain valleys in southern part of map area. Thickness variable, ranging Forms sharply defined lobate bodies with narrow-crested (1-10 m) arcuate moraines, Entirely underlain by permafrost, with active layer thickness ranging from 0.5 m in moist Gravelly glacial deposits having silt content below 6 percent are generally not frost Sand and gravel deposits provide good foundations, but irregular relief and steep slopes Subject to solifluction and earthflows on slopes. Deposits within steep-sided mountain from muddy sandy gravel to gravelly muddy sand, with local stratified ice-contact hummocky kame and kettle topography, and flat-topped, discontinuous kame terraces and up to several tens of meters. cause problems for heavy equipment. Clay- and silt-rich tills provide unstable swales up to 2 m on unvegetated moraine crests. Ice content generally low to moderate, susceptible. Compact unsorted tills are moderately frost susceptible; silty depression valleys are subject to landslides, rockfalls, and snow avalanches. Boulders in till deposits deposits consisting of moderately sorted sand and sandy gravel. Boulders are abundant in Younger kame deltas. Crests and upper slopes typically gravelly and well drained; lower slopes but silty depression fillings may be ice rich. foundations, especially on slopes. fillings are highly frost susceptible. may cause problems in excavation and drilling. glacial drift and swales of older deposits are filled with 2 to 5 m of poorly drained silt and organic Forms undulating till plains and low broad morainal ridges with gentle flanking slopes Unsorted to poorly sorted, generally nonstratified, compact till ranging in composition Most extensive along valleys of Kuna and Etivluk rivers and their tributaries in foothills Entirely underlain by permafrost, with active layer ranging in thickness from 0.3 m Compact unsorted tills are moderatley frost susceptible. Overlying silty deposits Clay- and silt-rich tills provide unstable foundations, especially on slopes. Overlying Subject to solifluction and earthflows on slopes. Overlying deposits are subject to from muddy sandy bouldery gravel to gravelly muddy sand. Local stratified ice-contact north of the Brooks range. Thickness ranges up to several meters. (except where steepened by postglacial erosion). Poorly drained except where slopes beneath heavy sod cover to about 1 m across lightly vegetated moraine crests. Ice thermal erosion where insulating vegetation is damaged. Boulders in till deposits may generally are highly frost susceptible, as are weathered tills with secondary silt deposits of ice-rich silt are generally unsuited for construction, and require special deposits consist of moderately sorted sand and sandy gravel. Generally weathered, with have been steepened postglacially. content of glacial deposits generally moderate, but silt cover generally is ice rich. 01der enrichment techniques such as insulated pads or thermopiles. cause excavation and drilling problems. glacial drift increased silt and clay content through weathering profile. Generally covered by thick (more than 2-3 m) blanket of nonstratified to weakly stratified silt, stony silt, and organic silt (loess, solifluction, thaw-lake, and muskeg deposits). Stony silt, stony clayey silt, and silty sand, faintly bedded to structureless, with Flat to gently undulating surfaces, rising toward valley sides at gentle (less than 3°) Widespread through southern third of map area. Particularly extensive across floor of Entirely underlain by permafrost, with active layer generally less than 0.5 m thick. Ice Most deposits are highly frost susceptible. Unsuitable for most construction activities. Limited construction may be possible if Generally unstable on slopes. Subject to slides and flows on river bluffs. Clay-rich disseminated stones up to boulder size. Contain some interstratified layers and lenses of Noatak valley and lower courses of its principal tributaries. Thickest in valley centers; gradients. Thaw lakes common. Drainage generally very poor, with widespread pools and content of younger and more sandy lake deposits is low to moderate; ice content of older special techniques such as insulated pads or thermopiles are employed. Discontinuous subsurface deposits form mud volcanoes and other extrusions where overburden removed, Glacial lake poorly sorted gravel. Grades laterally into sandy and gravelly beach deposits in some thinning toward valley sides. Maximum known thickness in river bluffs is 63 m, but total deposits generally is high. Overlying silty deposits are extremely ice rich, and commonly beach deposits along margins of Noatak basin provide locally favorable routes for as by river incision. Scattered boulders may impede drilling or excavations. Subject to deposits places. Older deposits commonly have surface blankets of silt, stony silt, and organic silt thickness in center of Noatak valley probably exceeds 100 m. contain ice wedges. thermal erosion following disturbance of vegetation covertransportation lines. (loess, solifluction, and thaw-lake deposits). Very poorly sorted, weakly stratified, subangular, silty sandy coarse gravel to moderately Occur through southern half of map area at mouths of avalanche chutes, steep mountain Fan-shaped to conical sloping surfaces with gradients ranging from 12°-25° (steep alpine Entirely underlain by permafrost, with active layer generally ranging in thickness from Generally suitable for construction except where overlying deposits are thick and ice rich Aufeis accumulation commonly occurs along stream channels during winter months. Moderately frost susceptible where poorly sorted and silty. Overlying deposits of sorted and stratified, subrounded to rounded, sandy gravel. Also includes (1) coarse, very fans) to 30-70 (alluvial fans at mouths of larger valleys). Generally well drained, but 0.5 m on vegetated older fans to 2-3 m beneath active stream channels. Ice content low Steep alpine fans are subject to snow avalanches and slushflows during spring and debris canyons, and larger tributary valleys with gentler gradients. Generally a few tens of organic-rich silt are highly frost susceptible. or where silt has been concentrated by weathering in older fan deposits. Larger fans poorly sorted, subangular to subrounded, silty sandy gravel of steep alpine fans and (2) Fan deposits meters thick, but some fans may be more than 100 m thick. older portions of some fans may be marshy where silt cap overlies fan gravels. to moderate, but overlying loess and solifluction deposits generally are ice rich where flows during summer. generally are excellent sources of borrow materials. well sorted silt, sand, and fine gravel of fan-deltas. thick and extensive. Ice wedges locally present. Forms widespread deposits on gentle to moderate slopes beyond limits of glacial deposits Very poorly sorted, nonstratified to weakly stratified, stony silt and organic silt. Beds, Forms smoothly sloping aprons and sheets that commonly occupy middle and lower flanks Entirely underlain by permafrost, with active layer generally 0.3 to 0.5 m thick. Ice Unsuitable for construction. Limited construction may be feasible using special Subject to downslope movement at rates up to several cm per year. Disturbance of north of Brooks Range. Locally present farther south on older glacial deposits and on lenses, and platy stones, where present, generally are oriented parallel to surface slope. of hills, ridges, and mountain flanks. Moderately to poorly drained, with marshy surfaces Solifluction content low to moderate in alluvial gravels, but overlying loess and solifluction deposits techniques to preserve permafrost and to limit damage due to downslope movements. insulating vegetation may cause development of bimodal failures ("tundra earthflows"). shale bedrock. Thickness generally 0.5 m to 3 m; locally up to 5 m thick in depressions at and some standing water. deposits generally are ice rich. Ice wedges common. slope bases. Moderately sorted silt, organic silt, and slightly clayey, sandy or stony silt. Generally On uplands of low to moderate relief, primarily within northern 25 percent of map area. Occupies higher parts of gently rolling ridge and valley terrain. Drainage generally poor, Extremely sensitive to disturbance during construction due to high ice content. Limited Entirely underlain by permafrost with active layer 0.3 to 1 m thick. Contains ice wedges Highly frost susceptible in most localities. Subject to thermokarst processes where vegetation cover disturbed. Readily gullied by Grades laterally into solifluction deposits on slopes steeper than about 1° - 2°. Thickness except on steep slopes and hillcrests. Bears abundant thaw-lake basins, both modern and structureless, but may contain contorted lenses of peat or organic-rich silt. Generally and very high volume of ice as interstitial grains, masses and lenses. construction may be feasible using special techniques to preserve permafrost. running water on slopes where vegetation has been disturbed or where sheet flow is Upland silt relict. bears tussock cover broken by frost boils. ranges from less than 1 meter to about 10 m. concentrated by construction activities or other surface disturbance. deposits Angular, unsorted, nonstratified rock debris. Maximum size is controlled by lithology, Forms cones and aprons with surface slopes generally 30° - 33°. Generally well drained, Occur along lower walls of mountain valleys and in cirques at valley heads. Thickness Entirely underlain by permafrost with active layer generally 1-2 m thick. Rock rubble Generally not frost susceptible where older and stabilized talus rubble has accumulated Generally not suitable due to steep slopes, unstable debris blocks, and continued influx of Subject to rock falls, slush avalanches, debris flows, and other alpine slope hazards. May ranging from a few decimeters on thinly bedded rock types to several meters where rocks ranges from a few centimeters at edges to 100 m or more in centers of cones and especially where deposition is active and debris is unvegetated. generally is ice-cemented below a few meters depth due to percolation and freezing of secondary silt through weathering or infiltration. rock rubble. Older and more stable talus deposits are suitable for limited use, especially undergo deep-seated creep due to deformation of interstitial ice. Talus deposits aprons. Also forms thinner (0.5 to 1.5 m) and generally discontinuous sheets over many more massive and resistant. where surface slopes have been lowered below angle of repose. Good source of rainwater and snow meltwater. uplands mapped as "bedrock". construction materials. Very poorly sorted, nonstratified, fine to coarse angular rock debris. Glacier deposits Most common in higher cirques and valleys of Siniktanneyak Mountain and in adjoining Entirely underlain by permafrost with active layer generally 0.5-2 m thick. Rock-glacier Glacier deposits form steep-fronted, lobate rubble masses that extend outward from Generally not frost susceptible except where secondary silt has accumulated in older Generally not suitable due to steep slopes, unstable debris blocks, and remote locations. Subject to rock falls, slush avalanches, debris flows, and other alpine slope hazards. commonly have matrix of finer debris in silt-to-sand range. Rock-glacier deposits parts of De Long Mountains. Thickness variable; generally about 30-100 m. Glacier cirque headwalls. Rock-glacier deposits, where active, have steep (35° - 38°) and highly deposits are ice-cemented below a few meters depth. inactive deposits. Good source of construction materials for transportation corridors traversing rugged Rock-glacier deposits move at rates up to several centimeters per year due to olocene olac contain abundant interstitial ice. deposits typically are restricted to cirques; rock-glacier deposits occur both in cirques unstable frontal slopes that meet upper surfaces at abrupt angles. Inactive rock glaciers alpine terrain. deformation of interstitial ice. and rock glacier have gentler, more rounded, more stable frontal slopes. All deposits are well drained. and along bases of steep valley walls. deposits Weakly stratified to nonstratified silt, organic silt, clayey to sandy silt, and peat. Most common on floor of Noatak valley and on uplands and terraces in northern part of Generally associated with thaw-lake basins and with other topographic depressions, Entirely underlain by permafrost. Active layer about 0.5 to 1 m thick; locally thicker High moisture and high silt content make this unit extremely susceptible to frost action. Unsuitable for structures and as source of construction material. Limited construction Subject to severe thaw settlement if insulating vegetation cover is disturbed. Commonly map area. More widely scattered elsewhere. Thickness ranges from about 2 m to 10 m beneath ponds and lakes. Thaw bulbs (taliks) occur beneath lakes deeper than about 2 generally in areas of locally gentle relief. Poorly drained, with ponds and marshes feasible only if special methods are employed to preserve permafrost. Silty and peaty flooded during spring snowmelt season. or more. depression fillings m. Generally ice rich, with ice wedges and lenses common. Silty, angular, unsorted rock debris on upper slopes; grading downslope into rubbly Most common along walls of mountain valleys above and beyond limits of Younger Forms sheets and aprons on middle and lower valley walls. Upper slopes tend to be Entirely underlain by permafrost. Rubbly deposits of upper slopes have thicker (1-2 m) Upper slopes moderately frost susceptible. Lower slopes subject to frost heave, thaw Upper slopes are steep, subject to frost creep, and commonly exposed to alpine mass-Subject to landslides, snow avalanches, debris flows, and rockfalls. Lower slopes subject solifluction deposits (poorly sorted, nonstratified to weakly stratified stony silt, and Glacial Deposits. Thickness ranges from 1-2 m up to several tens of meters. Includes relatively steep (up to about 30°), stony, and relatively well drained. Lower slopes are active layers and generally lower ice contents. Silty deposits of lower slopes have subsidence, solifluction, and other processes related to freezing and thawing. wastage hazards. Lower slopes are subject to slow flowage, and gulleying or bimodal to slow or rapid flowage, thermal erosion, or thaw settlement if insulating vegetation is organic silt). Interfingers with alluvium (coarse to fine gravel and sandy gravel) beneath widely scattered landslide deposits east of Nigu River, at south flank of Avingnak Hills, gentler (about 5° - 10°), more silty, and poorly drained. Colluvium thinner active layers (about 0.5 m) and commonly are ice rich. Ice wedges commonly are failures are likely if deposits are ice rich. Silt content generally too high to permit use floors of narrow mountain valleys. and within De Long Mountains near head of Wager Creek. present on lower slopes. as construction material. Hard to friable limestone, quartzite, sandstone, shale, and siltstone of Devonian through Extensive exposures through Brooks Range and De Long Mountains; forms narrower east-Underlies slopes of rugged to moderate steepness and relief in Brooks Range and De Long Permafrost extends into bedrock throughout map area. Active layer thickness highly Shale and siltstone subject to frost heaving, especially where weathered. All rock types Highest and steepest slopes generally contain durable rock types that are suitable for Locally subject to landslides (shown by hachures on map). Cretaceous age, with local masses of volcanic and ultramafic rock in the De Long west trending ridges farther north in Arctic Foothills. Exposed thicknesses up to 1000 m Mountains. Forms elongate ridges with gentle to moderate flanking slopes in Arctic subject to frost shattering along joints and bedding planes. variable owing to variations in rock type, overlying soils and vegetation, slope steepness, construction materials.

and slope aspect. Permafrost depth uncertain, but probably in order of 200 ± 50 m.

by

1984